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UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Agricultural Chemistry and Engineering

Carbohydrate Research Division

CARNAUBA WAX

Carnauba wax is obtained from the leaves of the palm Copernicia cerifera, which is found chiefly in Brazil in the states of Ceara, Piauhy, Parahiba, Rio Grande, do Norte, and Maranhao. The palm produces the wax only in those regions which have long dry periods.

The crop is gathered from September to March. From each palm six leaves not yet fully opened are cut off with pruning shears attached to a long pole. The leaves are cut from each palm two or three times during the harvesting season. These are graded into first and second qualities, and placed in direct sunlight to dry for three days. Then they are collected and placed in storage buildings until the wax can be removed from them. In a tightly closed room as much as possible of the wax is brushed from the dried leaves and a further recovery is made by beating them with switches. The wax is collected from the floor and transferred to tubs or vats half full of boiling water. After the wax has gathered in a mass on the surface of the water, it is removed and placed in coarse-mesh cotton cloths in order to separate the adhering water. When dry, the crude wax is a dull green or yellowish brittle mass. The wax is refined by melting it in hot water and slowly stirring with a paddle to facilitate the separation of plant debris. For further refining, it can be melted and filtered through a heated filter press. Sometimes before filtering, it is thoroughly mixed with 5 percent or more of bleaching earth. This treatment produces the yellow grades of the wax.

The commercial grades of the wax are as follows: No. 1 and No. 2 Yellow, No. 2 and No. 3 North Country, and No. 3 Chalky. The wax is used chiefly in the manufacture of various kinds of polishes, leather finishes, phonograph records and certain lacquers.

The wax melts at 80° to 86° C., gives an iodine number from 12 to 15, a saponification value from 67 to 88, and an acid value from 2 to 7.

Additional information on carnauba wax will be found in the following publications:

"Waxes: Animal, Mineral, Vegetable and Synthetic" by Ibert Mellan, Chemical Industries, vol. 37, pp. 539-545 (1935).

"Waxes: A Brief Study of the Polishing Waxes" by M. J. Hausman, Soap, vol. 12, No. 8, pp. 95-97 (1936).

"Chemical Technology and Analysis of Oils, Fats, and Waxes" by J. Lewkowitsch (3 volumes), published by MacMillan & Co., 1923.

Many city libraries, as well as those of agricultural experiment stations and universities, have these publications.

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General Information on the Chemistry of Eggs and Egg Quality Investigations

By
Sam R. Hoover,
Food Research Unit,
Agricultural Chemical Research Division,*
Bureau of Agricultural Chemistry and Engineering,
U. S. Department of Agriculture.

Hens' eggs had been an important food for man for thousands of years before the coming of modern biological chemistry. They have been extensively studied and analyzed by biologists and chemists during the past 50 years. An egg is made up of an outer protein film called the bloom, two layers (not readily separated) of shell, two shell membranes, three layers of white, the yolk membrane or vitelline membrane, and the yolk, which contains the germ or blastoderm. Diet has very little effect on the composition of eggs, except on the vitamin content, which is affected greatly. Fresh eggs vary in size and relative content of the various parts due to age of the hen, feed, breed, weather conditions, etc., but average about 57 grams (2 ounces) in weight. This weight is divided approximately as follows:

Shell ..... 12% White ..... 56% Yolk ..... 32%.

The secretion that lubricates the passage of the egg during laying dries to form the bloom. The shell and yolk membranes are protein substances (keratin) resembling feathers and hair in composition. These keratins are of no food value. The shell is composed of around 94 percent calcium carbonate, 1 percent magnesium carbonate, and 4 percent organic matter, chiefly protein. The thick white is distinguished from the two thin fractions by its content of a jelly-like protein, ovomucin, that holds the other proteins in a weak gel.

The chemical composition of the edible portion averages about as follows:

	Water	Protein	Fat	Ash
	%	%	%	%
White	86	13	0.2	0.6
Yolk	50	16	33.	1.1
Whole egg	74	14	12.	0.8

Small amounts, about 0.5 percent, of carbohydrates are also present.

The proteins of the white have been separated quantitatively by M. Sorenson (Biochem. Zeit., 269, 271 (1934)). He summarizes his results as follows: globulin, about 7 percent; mucin, about 2 percent; albumin,

*Formerly Food Research Division.

about 70 percent; conalbumin, about 9 percent; mucoid, about 13 percent. The yolk proteins are difficult to separate and are not so fully known; a phosphorus-containing protein ovovitellin, a globulin-like ovolivetin and a nuclein are known to be present, also lecitho-protein or phospholipin.

The excellent food value of eggs from the standpoint of protein and fat content is increased by the vitamins present. Egg yolk is one of the best sources of vitamins A, B and G (B_2) available in our diet, and egg white contains about half as much vitamin G as the yolk. Vitamin E is also present in the yolk, but no satisfactory method of assay for this vitamin is known. The value of eggs as a food is best shown by the fact that the complete healthy chick is produced on egg alone.

Chemists and technologists have also conducted numerous investigations of the best methods of storing, drying, freezing and thawing eggs. Measurement of the appearance of the broken-out egg has been exactly worked out, and the results of such studies have been applied to commercial practices. Volume III of Winton and Winton's "Structure and Composition of Foods", John Wiley & Sons, 1937, contains an excellent 50-page review of the chemistry of eggs. Sharp, in Food Research, vol. 2, page 477 (1937), reviews the investigations on egg storage to that date. Swenson has summarized the research and publications of the U. S. Bureau of Chemistry and Soils on the vacuum-CO_2 oiling process for preserving eggs in commercial storage. This summary may be obtained from the Food Research Division, Bureau of Agricultural Chemistry and Engineering.

Information on Egg Quality

An egg is a perishable commodity in which chemical and physical changes are taking place from the time it is laid until it is eaten. The consumer is interested in accurate detection of these changes, because he wants to obtain the full quality for which he pays. The producers and handlers of eggs have shown great interest in improving the methods of transporting and storing eggs. Because of this universal interest many investigators have endeavored to measure the changes in the condition or interior quality of eggs. The methods developed can be conveniently divided into candling of whole eggs and breaking out for visual inspection. There have been attempts to develop methods other than candling to judge the quality in unbroken eggs, but none of these has been very successful as yet.

Candling

The oldest and most valuable method for commercial purposes is candling. The ancient Egyptians used the sun's rays passing through a hole in the wall of a darkened room to separate infertile from fertile eggs. As early as 1849 commercial candling to eliminate bad eggs was practiced in this country. There was a gradual development of candling in succeeding years and in the last 25 years the practice has been

greatly extended. U. S. and State grades have been developed and an inspection service is maintained in all the principal producing areas and markets.

A typical candling outfit consists of a 20- to 50- watt bulb enclosed in a box that has a hole about the width of an egg in the side. When an egg is held before the candle in a darkened room, the position of the yolk and the size of the air cell can be seen. Eggs of high quality have a small air cell, and the yolk is centered well in the egg and does not appear to move when the egg is rotated in the hand. As the egg deteriorates the air cell becomes larger, and the yolk becomes more visible, sinks lower in the shell, and rotates freely when the shell is rotated.

An experienced candler has no difficulty in eliminating eggs that have developed rots or have started development of the embryo chick. Eggs that have been stored for some time or those exposed to high temperature and low humidity for a short time can also be distinguished. These distinctions are made according to standards set up as a result of wide experience. Copies of the current U. S. standards can be obtained from the Agricultural Marketing Service, U. S. Department of Agriculture. The various State standards agree closely with the U. S. standards and in many states are identical. Copies of the regulations in any particular state may be obtained from the State Department of Agriculture or the State Agricultural Experiment Station.

Broken Out Quality

During the past 10 years there have been developed several methods for measuring exactly the appearance of the egg when broken out on a flat plate. An obsolutely fresh egg has a round, even colored yolk surrounded by a jelly-like bag of white called thick or firm white. Inside this bag of thick white is a layer of thin white, and an outer layer of thin white surrounds the thick white. As the egg ages, the thick white weakens and spreads out, the weaker gel breaks readily, and the inner thin white escapes. Finally, in eggs that are badly broken down the thick white practically disappears. The yolk membrane also becomes progressively weaker and the yolk flattens out and breaks easily during the later stages of breakdown.

Sharp and Powell (Ind. Eng. Chem., 22, 908 (1930)) proposed the ratio of the height to the width of the yolk, or the yolk index, as a quantitative measure of the breakdown of the yolk. Holst and Almquist (Hilgardia, 6, 49 (1931)) proposed the percentage of the thick white as a measure. These two methods are of value in many investigations, but they indicate only gross changes in the quality of the eggs.

A set of 9 pictures that illustrate the successive steps in the spreading out of the white was prepared by Van Wagenon and Wilgus in 1935 (Jour. Agr. Res., 51, 1129). Eggs can be compared with these pictures and scored accordingly. This photographic scoring technique

is very simple and rapid, and the method has been used successfully in many investigations.

Laboratory workers, however, have felt the need of more exact methods which can be used in studying processing operations, developing a more exact method of candling, etc. The use of a vertical caliper to measure the height of the white was developed almost simultaneously at Washington State College (Poultry Science, 15, 141 (1936)) and at Cornell University (Poultry Science, 15, 319 (1936)).

Parsons and Mink (U. S. Egg & Poultry Mag., 43, 484 (1937)) compared the methods in use at that time and found that the area of the thick white showed fairly good correlation with the photographic score.

Hoover (Jour. Assoc. Off. Agr. Chem., 21, 496 (1938)) simplified the method of measuring this thick white area. The egg is broken onto a wooden plate marked with rings at various distances from the slightly concave center. The length and width of the thick white can be read off and the area determined from charts prepared for this purpose.

It can be seen that these later methods are attempts to measure exactly the appearance of the egg. By the use of such methods a great deal of fundamental data on the best conditions for producing and storing eggs has been obtained. The comprehensive bibliography on this subject compiled by Wilhelm (U. S. Egg & Poultry Mag., 45, 563 (1939)) contains more than 300 references. It was followed in subsequent issues by a comprehensive review of the articles cited in the bibliography and anyone wishing detailed information on any particular phase of the subject should refer to this compilation and review.

Applications of the methods discussed above to various practical problems are made in a group of papers by Wilhelm, Haugh, Van Wagenen, Hall and Altmann, Hoover and Rogers, and others that were presented at the Seventh World Poultry Congress, 1939, and are published in the Proceedings of that meeting (Seventh World's Poultry Congress and Exposition, Proceedings. Section 6, Poultry Products Research).